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# Dundee Discussion Papers in Economics

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## Political Risk, Economic Integration, and the Foreign Direct Investment Decision

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# POLITICAL RISK, ECONOMIC INTEGRATION, AND THE FOREIGN DIRECT INVESTMENT DECISION

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## Abstract

In this paper we analyse the impact of policy uncertainty on foreign direct investment strategies. We also consider the impact of economic integration upon FDI decisions. The paper follows the real options approach, which allows investigating the value to a firm of waiting to invest and/or disinvest, when payoffs are stochastic due to political uncertainty and investments are partially reversible. Across the board we find that political uncertainty can be very detrimental to FDI decisions while economic integration leads to an increasing benefit of investing abroad.

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**Keywords:** Political Risk; Real Options; Investment; Foreign Direct Investment

**JEL-Classification:** D81, D92, E22, F21

## 1. Introduction

The foreign direct investment (FDI) literature is extensive and consists of three mainstream models. The so-called OLI model is a model that tries to identify the attractiveness of a country for foreign investors on the basis of ownership, location and internationalisation factors [Dunning (1993)]. The gravity model tries to predict FDI flows on the basis of macroeconomic variables like the level of GDP, GDP growth and the population size [Brenton and Gros (1997), Brenton and Di Mauro (1998), Brock (1998)]. The transaction costs models try to determine which mode of investment is most suited for a business based on its cost structure [Buckley and Casson (1981)]. This stream of research examines firm choices among alternative market-servicing modes, such as exporting, licensing, or joint ventures in addition to full ownership.

Contrary to this literature, the recent literature on investment interprets a firm as consisting of a portfolio of options, and uses options-based pricing techniques to study the investment decision. The general idea behind the idea that investment opportunities are option-rights is that each investment project can be assimilated, in its nature, to the purchase of a financial call option, where the investor pays a premium price in order to get the right to buy an asset for some time at a predetermined price (exercise price), and eventually different from the spot market price of the asset (strike price). Analogously, the firm, in its investment decision, pays a price (the cost of setting up the project) which gives her the right to use the capital (exercise price), now or in the future, in return for an asset worth a strike price. Taking into account this options-based approach, the calculus of profitability cannot be done simply applying the net present value rule to the expected future cash flows of the operation, but has rather to consider the following three characteristics of the investment decision:

1. there is uncertainty about future payoffs from the investment;
2. the investment does not entail a now-or-never decision and
3. the investment is at least partially irreversible.

The three characteristics imply that the opportunity cost of investment includes the value of the option to wait that is extinguished when an investment decision is taken. Therefore, the investment decision is affected by the determinants of the value of this option and consequently, an appropriate identification of the optimal exercise strategies for real options plays a crucial role in the maximisation of a firm's value.<sup>1</sup>

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<sup>1</sup> Most of the FDI literature relies on non-stochastic models. Some notable exceptions include Buckley and Tse (1996), Clark (2003), Goldberg and Kolstad (1995), Tong and Reuer (2007) and Wong (2006). Aizenman and Marion (1993) have constructed an endogenous growth model that focuses on irreversible investment as a channel that links policy volatility and growth. All these papers model uncertainty via a geometric Brownian motion. Garibaldi et al. (2002) has confirmed that the quality of institutions and governance and macroeconomic stability are important factors in determining the level and regional allocation of FDI flows.

Almost uniformly, the real options literature focuses on the effect of demand, price and/or exchange rate uncertainty upon investment decisions of firms.<sup>2</sup> The scope of this paper is to apply the real option theory to the case of foreign direct investment under political instability, i.e. we aim to explain FDI decisions with a specific focus on the political environment. For our purpose we describe political risk as the risk that arises from the potential actions of governments and/or other influential forces which threaten expected returns on investment. Closely linked to political risk is the concept of political instability which is generally defined as the propensity of an imminent government change, either by constitutional (elections) or unconstitutional means (revolutions or coups d'état).

Another form of uncertainty faced by investors is the imperfect credibility of policy reforms. Investment-friendly reforms typically raise expected returns, but may also increase uncertainty if investors believe that the reform measures could be reversed. In such context, investors' perceptions about the probability of policy reversal become a key determinant of the investment response. These issues are explored by Rodrick (1991) using a model in which investment involves sunk costs of entry and exit. He shows that a reform favourable to capital, but regarded as less than fully credible, will fail to trigger off an investment response unless the return on capital becomes high enough to compensate investors for the losses they would incur should the reversal take place. Similar qualitative conclusions are reached by van Wijnbergen (1985) who considers the case of a trade reform suspected to be only temporary.<sup>3</sup>

The hypothesis that an unstable political environment can become a powerful aggregate investment deterrent seems to be supported by mounting empirical evidence. Barro (1991) and Alesina and Perotti (1996) find that measures of government instability, unrest and political violence are significantly related to cross-country differences in investment and growth. Keefer and Knack (1995) show that indicators of uncertainties in property rights enforcement (perceived risk of expropriation and repudiation of contracts) derived from expert surveys are negatively associated with private investment performance across countries. Pindyck and Solimano (1993) and Mauro (1995) find that political uncertainty and an aggregate institutional indicator (a bribery and corruption indicator) is negatively associated with aggregate investment spending. Brunetti and Weder (1998) have found that high corruption, a lack of rule of law, and volatility in real exchange rate distortions are most detrimental to aggregate investment spending. The literature concerning the empirical investigation of

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<sup>2</sup> The literature is too vast to survey here. Excellent surveys of the real options literature are provided by Amran and Kulatilaka (1999), Copeland and Antikarov (2001), Coy (1999), Dixit and Pindyck (1994) and Lander and Pinches (1998). Graham and Harvey (2001) survey a large representative set of US firms and find that a quarter of them incorporates the real options of a project when evaluating it.

<sup>3</sup> It should be pointed out, however, that a higher level of investment may encourage the host government to change policies in the future, so that a firm anticipating this kind of time inconsistency will tend to be self-protective, assuming that the jump parameter is positively correlated with the stock of invested capital and therefore an endogenous variable. See Cherian and Perotti (2001) for a discussion of the effects of strategic interactions drawing inspirations from the time-inconsistency literature. In the context of transition economies, a number of governments have employed external policy bindings like the eastern enlargement of the EU as a means to alleviate investor concerns about policy uncertainty.

the main macroeconomic determinants of FDI flows, also connotes the importance of political and economic instability. Finally, Busse and Hefeker (2007) show that foreign direct investment is highly affected by various factors of political risk, such as government stability, internal and external conflict, law and order, corruption, ethnic tensions, and quality of bureaucracy.

The remainder of this paper is constructed as follows. The next section of the paper describes the model and assumptions, drawing inspiration from the real options literature. In section 3, we derive the analytical solution and section 4 contains a numerical analysis. Finally, section 5 provides a summary and some general comments pertaining to policy implications and future research.

## 2. The Basic Model of Investment with Adjustment Costs

Formally, we assume an economy where the individual firm maximises the intertemporal objective function

$$(1) \quad V = \int_0^{\infty} (\pi(K_t) - C(I_t)) e^{-rt} dt$$

where  $\pi(\cdot)$  is the twice differentiable maximised value of the firm's instantaneous profits with  $\pi_K > 0$  and  $\pi_{KK} < 0$ ,  $r$  is the discount rate, and  $C(\cdot)$  are the total investment expenditures.<sup>4</sup> The firm is risk-neutral, but the owners may be risk averse.<sup>5</sup> These standard assumptions guarantee that the firm's problem is well-behaved. The total costs of investment are determined by

$$(2) \quad C(I) = \begin{cases} a_K + p_K^+ I + c(I) & \text{for } I > 0 \\ 0 & \text{for } I = 0 \\ a_K + p_K^- I + c(I) & \text{for } I < 0 \end{cases}$$

Fixed costs  $a_K$  are non-negative costs of investment that are independent of the level of investment. However, a firm can avoid these fixed costs by setting investment to zero. Purchase (sale) costs are the costs of buying (selling) capital. Let  $p_K^+$  ( $p_K^-$ ) be the price per unit of investment good at which the firm can buy (sell) any amount of capital. We assume that  $p_K^+ \geq p_K^- \geq 0$ .<sup>6</sup> Adjustment costs  $c(\cdot)$  are

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<sup>4</sup> In the model, capital is the only fixed factor, while other productive inputs (e.g., labour) can be costlessly adjusted in the face of changing prices. In other words,  $\pi(\cdot)$  accounts for whatever optimisation the firm can do on dimensions other than  $K$ .

<sup>5</sup> The assumption of risk-neutrality can be relaxed and risk aversion can be assumed instead by using the CAPM and calculating a risk-adjusted discount rate. See Harrison and Kreps (1979), for example.

<sup>6</sup> Thus, we relax the assumption that FDI be irreversible. Instead we assume that reversibility is a continuous rather than a dichotomous concept. The assumption of complete irreversibility is given by  $p_K^- = 0$ .

continuous and strictly convex in  $I$  satisfying  $c(0) = 0$ ,  $c_I > 0$  and  $c_{II} > 0$ . Considering the depreciation of capital, the adjustment of capital over time is denoted by

$$(3) \quad \frac{dK}{dt} = I - \delta K ,$$

where  $\delta$  represents the depreciation rate. To solve the model, we consider the Bellman equation

$$(4) \quad rV = \pi(K) - C(I) + \frac{E[dV]}{dt} = \pi(K) - C(I) + q(I - \delta K) .$$

The first condition characterising the optimum is the derivative of the Bellman equation with respect to the control variable ( $I$ ) is zero, i.e.

$$(5) \quad p_K^{+/-} + c_I = q ,$$

where  $q \equiv V_K$  denotes Tobin's marginal  $q$ . Note that since  $C_I$  is increasing in  $I$ , equation (5) implies that investment is increasing in  $q$ , i.e.

$$(6) \quad I_t = f(q_t) \quad \text{with } f(p_K^{+/-} = 1) = 0 \text{ and } f' > 0 .$$

The above model of investment has at least one failure as a description of actual behaviour. Our analysis so far assumes that firms are certain about future revenues. In practice, however, they face uncertainty. Thus we need to modify the model if we are to obtain a reasonable picture of actual foreign direct investment decision. To evaluate such impacts, it is necessary to recognise that investment and production are inherently dynamic and uncertain processes. Acknowledging the high degree of irreversibility associated with FDI ventures, let's assume that FDI decisions may be represented by a set of real options to acquire productive assets abroad. Consequently, an appropriate identification of the optimal exercise strategies for real options plays a crucial role in the maximisation of the firm's value. So far, the real options literature provides relatively little insight into the impact of institutional and policy uncertainty on the investment decision of a firm although many people would agree with the view that policy uncertainty and instability can be serious obstacles to fixed investment decisions. The existing papers mainly consider continuous changes in the value of relevant variables. This, most of the time, results in the assumption that the entire uncertainty in the economy can be

described by a geometric Brownian motion.<sup>7</sup> It is, however, more realistic to model institutional and policy uncertainty as a process that makes infrequent but discrete jumps. In such cases, use can be made of the Poisson jump process.<sup>8</sup>

On the supply side of the economy, we assume that the present value of operating profits is given by

$$(7) \quad \pi(K_t) = (1-t)gK^a$$

where  $t$  represents transportation costs.<sup>9</sup> We think of transportation costs as a stand-in for tariffs and non-tariff barriers, in addition to direct transport costs. We model these costs as iceberg costs. Specifically, if  $gK^a$  profits are earned abroad, then  $tgK^a$  profits are lost in transit. The productivity parameter  $g$  is intended to proxy for all aspects of the environment of the host country impinging on the incentive to invest, such as demand and exchange rate fluctuations, capital control regulations, weak and poorly enforced property rights, government instability, unstable incentive frameworks, discontinuous changes in the tax environment, social unrest, etc. In other words,  $g$  measures the host country's potential in generating profits. In this paper, we propose a simple unifying framework where the parameter  $g$  is allowed to jump or drop, combined with continuous-time stochastic process. Consequently, our objective is to model explicitly the dynamics of policy uncertainty and its effect on foreign direct investment when the firm has incomplete information about the moment of the change. This feature of the policy process is particularly relevant in developing countries and transition countries where investors may be particularly wary of the potential for radical and unexpected swings in economic policy. It is assumed that  $g$  follows the combined geometric Brownian motion and jump process

$$(8) \quad dg = \eta g dt + \sigma g dW + d\tau_1 + d\tau_2,$$

where  $W$  is a Wiener process;  $dW = \varepsilon_t \sqrt{dt}$  (since  $\varepsilon_t$  is a normally distributed random variable with mean zero and a standard deviation of unity, and  $\varepsilon_t$  is serially uncorrelated due to the assumption of independent increments),  $\eta$  is the drift parameter,  $\sigma$  the variance parameter,  $d\tau_1$  and  $d\tau_2$  are the

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<sup>7</sup> The use of option-pricing models that capture the role of uncertainty in international economics is well-established since the mid 1980s. Some of the most influential contributions focused on providing a theoretical argument to explain the hysteretic effect that the large exchange rate swings of the 1980s had on trade prices and quantities. Foreign firms that entered the U.S. market during the first half of the 1980s, when the real U.S. Dollar exchange rate was appreciating, could not exit when the U.S. Dollar returned to its original level due to the sunk costs incurred. The exchange rate would have had to decline strictly below the level that triggered entry in order to induce firms to exit [see, for example, Baldwin (1988) and Baldwin and Krugman (1989)].

<sup>8</sup> An interesting recent application is provided by Hassett and Metcalf (1999) who analyse changes in the investment tax credit in a setting where a Poisson process describes discrete changes in the tax regime.



increments of Poisson processes (with mean arrival rates  $\lambda_1$  and  $\lambda_2$ ). With this process,  $\eta$  is the expected growth rate of profitability, i.e.  $E[(g/g_t)|g_t] = \exp[\eta(\tau-t)]$  for  $\tau \geq t$ .<sup>10</sup> It is assumed that if an “event 1” (“event 2”) occurs,  $g$  increases (falls) by  $\phi_1$  ( $\phi_2$ ) percent with probability 1. Over each time interval  $dt$  there is a probability  $\lambda_1 dt$  (or  $\lambda_2 dt$ ) that it will rise (drop) by  $\phi_1 g$  ( $\phi_2 g$ ) and  $Z$  fluctuates until next event occurs. Additionally, we assume that  $(d\tau_1, d\tau_2)$  and  $dW$  are independent to each other, i.e.  $E(dW d\tau_1) = 0$ ,  $E(dW d\tau_2) = 0$ , and  $E(d\tau_1 d\tau_2) = 0$ . Equation (8) indicates that there are two sources of uncertainty. Type I uncertainty represented by the geometric Brownian motion captures exchange rate and/or demand uncertainty. To understand FDI behaviour, we should also consider the political risks investors are facing. We have therefore additionally assumed type II uncertainty (represented by the independent jump processes). This newly added uncertainty represents political and/or institutional uncertainty.<sup>11</sup> In our work, the timing of the potential policy shifts is exogenous.<sup>12</sup> To complete the economic model, we are assuming quadratic costs of adjustment in order to replicate the empirical fact that the capital stock displays considerable smoothness and inertia

$$(9) \quad c(I) = \frac{\gamma}{2} I^2.$$

In the scenario hypothesised below, it is assumed that the firm assigns constant probabilities of the government changing policy, i.e. it is time itself and not the state of the economy that governs the change. The next section solves the real options setup under political uncertainty.

### 3. Solution to the Optimal Stopping Problem

The decision whether or not to engage in FDI constitutes an optimal stopping problem, for which the relevant Bellman equation is

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<sup>9</sup> Transportation costs are essential since without transportation costs there is no geography and therefore it is unclear why a firm should invest abroad rather than domestically.

<sup>10</sup> The drift parameter may represent productivity improvements during the catching-up process of transition economies.

<sup>11</sup> Recall that one might distinguish two types of political variables: on one hand, variables such as interest rates which, although political in the sense of being set or influenced by government, are represented by type I uncertainty; on the other, variables, such as a government’s announcement of costly politically-inspired laws and regulations or, even, expropriation. These variables signalling a shift from one profit function to a completely different one are represented by type II uncertainty. There are a few papers that have performed related work but none has emphasized the interaction between type I and type II sources of uncertainty that surround FDI decisions. On a methodological level, the closest work to ours is that of Dixit and Pindyck (1994), pp. 303-309.

<sup>12</sup> An important assumption of the model is that investment does not resolve political uncertainty, it is time that resolves uncertainty. Clearly, this assumption will not be valid for other types of uncertainty in which the firm gains the critical information *because* it has invested. For example, R&D investments will give the firm information about the likelihood of a product’s success. In practical terms, we are not exploring endogenous uncertainty but exogenous uncertainty that may (or may not) be resolved with time but cannot be resolved by action on part of the firm.

$$(10) \quad rV = (1-t)gK^a - \left[ a_K + p_K^{+/-}I + \frac{\mathcal{I}^2}{2} \right] + V_K(I - \delta K) + \eta g V_g + \frac{1}{2} \sigma^2 g^2 V_{gg} \\ + \lambda_1 [V(g(1+\phi_1)) - V] - \lambda_2 [V - V(g(1-\phi_2))] ]$$

and the optimal condition for  $I$  is denoted by

$$(11) \quad p_K^{+/-} + \mathcal{I} = q \Rightarrow I = \frac{q - p_K^{+/-}}{\gamma}.$$

In this framework, the optimal investment strategy is a two-trigger policy that can be expressed in terms of Tobin's  $q$ . If  $q$  exceeds the upper threshold  $q_K^+$  gross investment occurs. In turn, if  $q$  falls below a lower threshold  $q_K^-$ , negative investment takes place – the firm sells part of its capital stock. In the region of inaction  $p_K^- \leq q \leq p_K^+$ , investment equals zero. Table 1 gives the intuition behind this result.

**Table 1: The Optimality Conditions**

	Marginal Benefit (MB)	Marginal Cost (MC)	MB=MC and $I = 0$
$I \geq 0$	Firm's value raised by $q$	Buying additional $K$ for price $p_K^+$ and paying for marginal adjustment cost for $K$ : $\mathcal{I}$	$q_+ = p_K^+ + \mathcal{I}$ $\Rightarrow q_+ = p_K^+$
$I \leq 0$	Selling the redundant $K$ for $p_K^-$	Firm's value reduced by $q$ and paying for marginal adjustment cost for $K$ : $-\mathcal{I}$ since $I$ is negative	$q_- - \mathcal{I} = p_K^-$ $\Rightarrow q_- = p_K^-$

Given (11), the firm's solution to the optimal stopping time requires

$$(12) \quad -a_K - p_K^{+/-}I - \frac{\gamma}{2}I^2 + V_K(I - \delta K) = -a_K - p_K^{+/-}I - \frac{\gamma}{2}I^2 + (p_K^{+/-} + \mathcal{I})(I - \delta K)$$

or, equivalently

$$(13) \quad \frac{\mathcal{I}^2}{2} - a_K - \delta(p_K^{+/-} + \mathcal{I})K = \frac{(q - p_K^{+/-})^2}{2\gamma} - a_K - \delta qK.$$

Substituting into the Bellman equation (10) we have

$$(14) \quad rV = (1-t)gK^a + \frac{(q - p_K^{+/-})^2}{2\gamma} - a_K - \delta qK + \eta gV_g + \frac{\sigma^2}{2} g^2 V_{gg} \\ + \lambda_1 [V(g(1+\phi_1)) - V] - \lambda_2 [V - V(g(1-\phi_2))]$$

Using the definitions  $q = V_K$ ,  $q_g = V_{Kg}$ ,  $q_K = V_{KK}$  and  $q_{gg} = V_{Kgg}$  and differentiating both sides with respect to  $K$ , we are able to rewrite (14) in the following form:

$$(15) \quad (r + \delta)q = a(1-t)gK^{a-1} + \frac{(q - p_K^{+/-})q_K}{\gamma} - \delta q_K K + \eta gq_g + \frac{\sigma^2}{2} g^2 q_{gg} \\ + \lambda_1 [q(g(1+\phi_1)) - q] - \lambda_2 [q - q(g(1-\phi_2))]$$

The optimal stopping problem is simplified by observing that we have  $q = p_K^+$  and  $q = p_K^-$  within the no-action region. In this case, equation (15) therefore takes the following simpler form

$$(16) \quad (r + \delta)q = a(1-t)gK^{a-1} - \delta q_K K + \eta gq_g + \frac{\sigma^2}{2} g^2 q_{gg} \\ + \lambda_1 [q(g(1+\phi_1)) - q] - \lambda_2 [q - q(g(1-\phi_2))]$$

The solutions for (16) consist of the particular and general solutions, i.e.  $q = q^P + q^G = p_K^{+/-}$ . Given the above model, we can show that the following holds:<sup>13</sup>

$$(17) \quad q^P = \frac{a(1-t)gK^{a-1}}{r + a\delta - \eta - \lambda_1\phi_1 + \lambda_2\phi_2}$$

$$(18) \quad q^G = -A_1 (gK^{a-1})^{\beta_1} + A_2 (gK^{a-1})^{\beta_2}$$

$$(19) \quad \frac{1}{2}\sigma^2\beta(\beta-1) - \delta\beta(a-1) + \eta\beta + \lambda_1[(1+\phi_1)^\beta - 1] - \lambda_2[1 - (1-\phi_2)^\beta] - (r + \delta) = 0$$

where  $A_1$  and  $A_2$  are unknown parameters and  $\beta_1$  and  $\beta_2$  are the positive and negative roots of the characteristic equation (19), respectively. The set of boundary conditions that applies to this optimal stopping problem is composed by the value-matching and smooth-pasting conditions

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<sup>13</sup> See Appendix A and B for formal proofs. Outside and inside the no-action-area, the problem in its general form has no closed form solution because the term  $\frac{(q - p_K^{+/-})q_K}{\gamma}$  does not disappear.

$$(20) \quad \frac{a(1-t)g_+K^{a-1}}{r+a\delta-\eta-\lambda_1\phi_1+\lambda_2\phi_2} - A_1(g_+K^{a-1})^{\beta_1} + A_2(g_+K^{a-1})^{\beta_2} = p_K^+$$

$$(21) \quad \frac{a(1-t)g_-K^{a-1}}{r+a\delta-\eta-\lambda_1\phi_1+\lambda_2\phi_2} - A_1(g_-K^{a-1})^{\beta_1} + A_2(g_-K^{a-1})^{\beta_2} = p_K^-$$

$$(22) \quad \frac{a(1-t)K^{a-1}}{r+a\delta-\eta-\lambda_1\phi_1+\lambda_2\phi_2} - A_1\beta_1g_+^{\beta_1-1}K^{(a-1)\beta_1} + A_2\beta_2g_+^{\beta_2-1}K^{(a-1)\beta_2} = 0$$

$$(23) \quad \frac{a(1-t)K^{a-1}}{r+a\delta-\eta-\lambda_1\phi_1+\lambda_2\phi_2} - A_1\beta_1g_-^{\beta_1-1}K^{(a-1)\beta_1} + A_2\beta_2g_-^{\beta_2-1}K^{(a-1)\beta_2} = 0.$$

The value matching conditions require the equality between the net present value of the project and the value of the option. The smooth pasting conditions require the equality between the slopes of the net present value of the investment project and the value of the option. Equations (19) – (23) determine the two thresholds ( $g_+$  and  $g_-$ ) that bisect the firm's decision-making space into a zone where it is optimal to exercise the option and a no action zone where the firm maximises its value by leaving the option unexercised. In other words, in the no action range between  $g_+$  and  $g_-$  the firm's optimal policy is to continue with the status quo, i.e. the firm will neither invest nor disinvest.

The next section makes use of numerical techniques to generate simulations of the demand of fixed assets exposed to political risk.

#### 4. Numerical Simulations

To have a feel on the quantitative importance of the various parameters discussed above, we present some numerical examples. All simulations are performed with regard to a benchmark case (see Appendix C for a description of the benchmark parameters).<sup>14</sup> In order to check the sensitivity of the thresholds to these benchmark parameters, optimal decision rules are then computed for alternative parameter combinations.

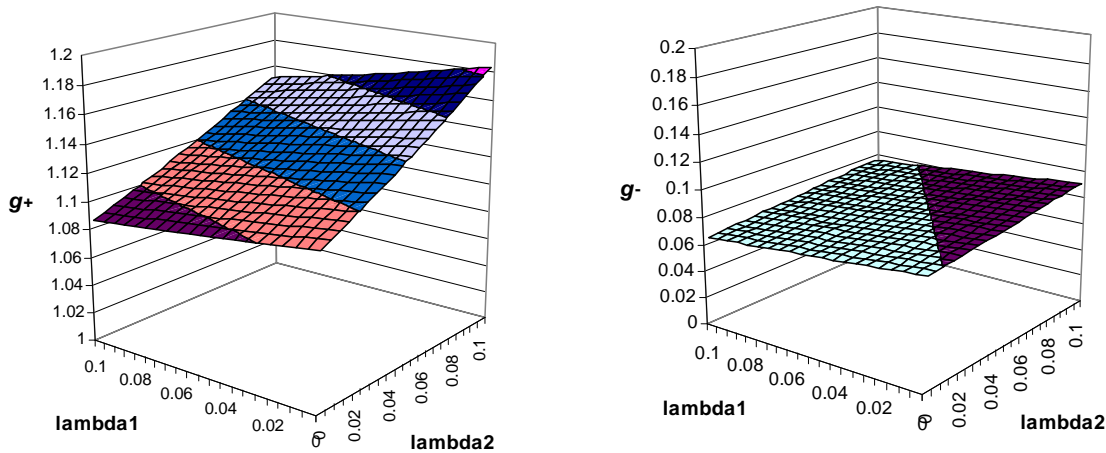
Figure 1 provides a sensitivity analysis of the thresholds with respect to  $\lambda_1$  and  $\lambda_2$ , i.e. we illustrate the impact of alternative arrival rates upon the optimal investment and dis-investment thresholds. The 3-D graphs clearly indicate the entire no-action areas. If  $\lambda_2$  increases, then the  $g_+$  investment threshold will rise – firms will be more reluctant to invest to avoid getting caught with too much capital, should the future turn out worse than expected. By contrast, if the future turns out better than expected, the firm can just add more capital as needed. The implication is that the textbook net present value rule is blatantly inappropriate in any context other than the unrealistic setting where sunk costs are negligible and there is certainty regarding the determinants of the profitability of the project to be undertaken. On

<sup>14</sup> The numerical boundary value problem is solved with the method of Newton-Raphson for nonlinear systems. A description of the numerical programming technique is provided in Press et al. (2002).

the contrary, if  $\lambda_I$  increases, then the  $g_+$  threshold declines. The less accentuated curvature of the  $g_+$  threshold with respect to  $\lambda_I$  results because there are two offsetting effects. First, an increase in  $\lambda_I$  increases the option value of waiting and therefore delays investment decisions. On the other hand, a higher  $\lambda_I$  parameter raises expected profitability and, *ceteris paribus*, the desired capital stock.<sup>15</sup> This effect goes in opposite direction to the threshold effect above, and the net result is in general indeterminate. This qualitative result is consistent with Bernanke's (1983) bad news principle: under investment irreversibility, bad events affect the firm's propensity to invest.<sup>16</sup>

**Figure 1: The Threshold Values as Functions of  $\lambda_I$  and  $\lambda_2$**

(The values of the other parameters are those presented in Appendix C)



Let us next examine how the drift term affects the firm's decision. Figure 2 shows the thresholds for  $\eta = 0.00$ . This makes no meaningful difference to the profit maximising tactic except that political instability poses an even more formidable obstacle to FDI decisions.<sup>17</sup>

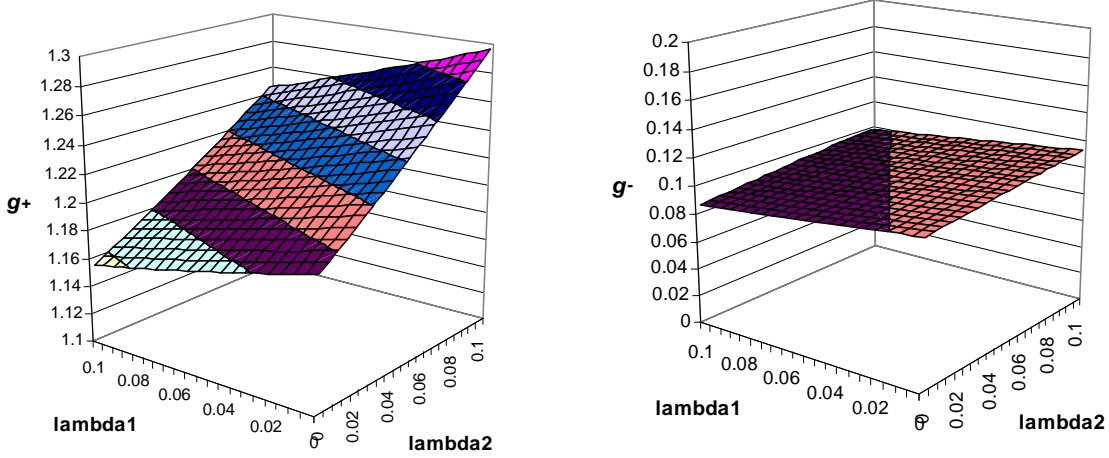
<sup>15</sup> Or said another way, in some cases the  $g_+$  threshold *falls* as uncertainty *increases*; the threshold elasticity of investment is negative. One may describe this behaviour as *inferior*.

<sup>16</sup> As stated by Bernanke (1983, pp. 92-93), "The investor who declines to invest in project  $i$  today (...) gives up short-run returns. In exchange for the sacrifice, he enters period  $t+1$  with an „option“ (...). In deciding whether to „buy“ this option (...), the investor therefore considers only „bad news“ states in  $t+1$  (...)."

<sup>17</sup> These large premia are consistent with the high hurdle rates applied in practice by firm managers when assessing investment projects.

**Figure 2: The Threshold Values as Functions of  $\lambda_1$  and  $\lambda_2$  for  $\eta = 0.00$**

(The values of the other parameters are those presented in Appendix C)



**Figure 3: The Threshold Values as Functions of  $\phi_1$  and  $\phi_2$**

(The values of the other parameters are those presented in Appendix C)

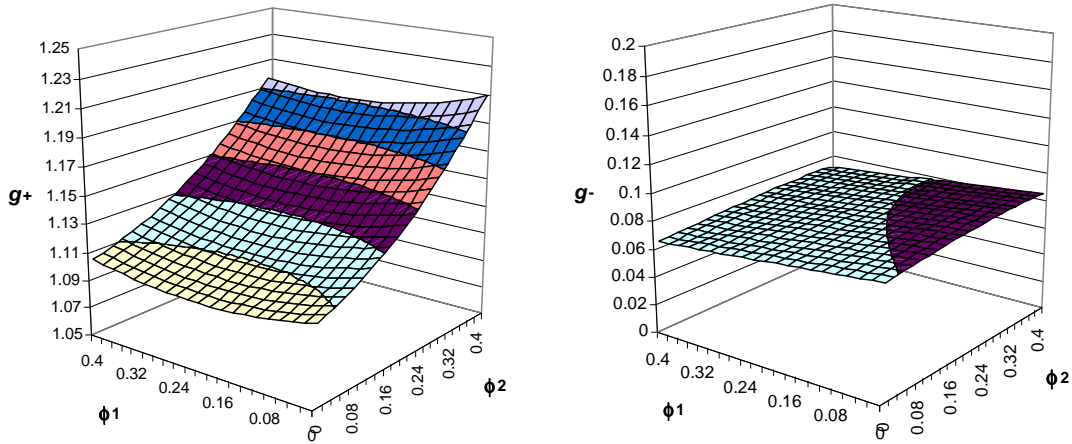


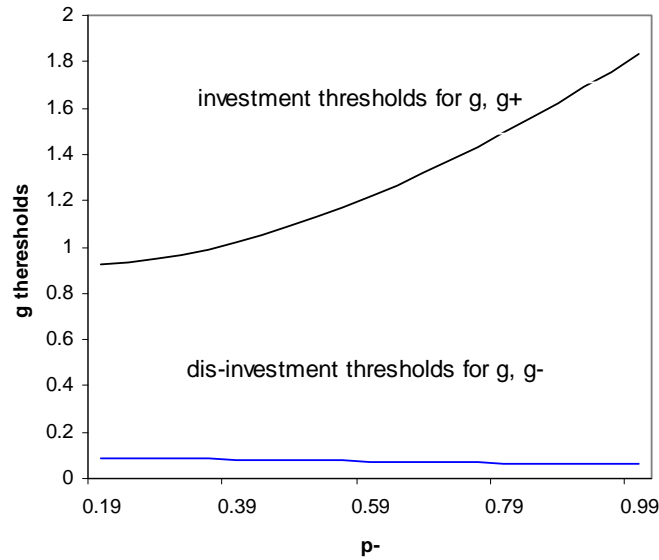
Figure 3 shows how the magnitude of the jumps (represented by  $\phi_1$  and  $\phi_2$ ) affects investment. Two main messages emerge from Figure 3. The first concerns the investment threshold: The simulations suggest that perceived downside risks act as an important deterrent to FDI. *Pari passu*, an unreliable political environment system translates into a higher no action area and hence lowers FDI and the efficiency in the host country's economy. This implies that a nation that takes steps to increase the degree of political stability could expect significant increases in the level of FDI into their country. This increased investment translates into more resources, which in turn increases social welfare and economic efficiency. The impact of  $\phi_1$  on the optimal investment rule is non-monotonic. This is due to the fact that there are two terms that depend upon  $\phi_1$ . The first of these is the option value of waiting

which is increasing in  $\phi_l$  while the second is expected profitability. As a result, at first glance the relation between  $\phi_l$  and  $g_+$  is ambiguous. The second argument concerns the dis-investment threshold. Again the result is that the threshold for dis-investment is rather flat.

Let us now consider changes in  $\sigma$ . In other words, we analyse the sensitivity of the optimal thresholds with respect to changes in the volatility of the geometric Brownian motion representing demand and/or exchange rate uncertainty for given values of political uncertainty. As in the existing literature, we find that the threshold value at which investment takes place is increasing in the “noisiness” level even though the firm is risk neutral. In volatile environments, the best tactic is to keep options open and await new information rather than commit an investment today.<sup>18</sup>

**Figure 4: The Threshold Values as Function of  $\sigma$**

(The values of the other parameters are those presented in Appendix C)

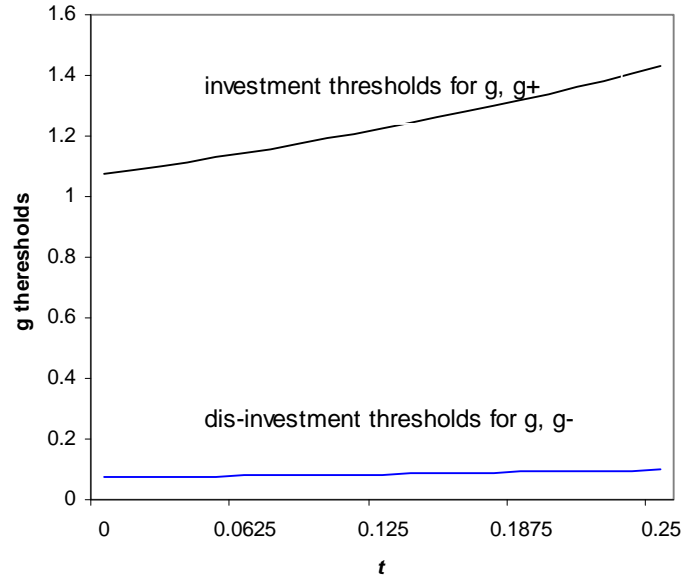


The final issue that we wish to explore is whether the relationship between FDI and risk is sensitive to different levels of integration. More specifically, we consider transportation cost changes. Intuition tells us that increasing integration leading to declining transportation costs (lower  $t$ ) should lower the no action area. Indeed this is the case, as depicted in Figure 5. Furthermore, the core prediction of the three-dimensional graphs in Figure 6 and 7 is that the importance of the political risk measured via  $\phi_2$  or  $\lambda_2$  is decreasing in  $t$ . The numerical results therefore indicate that integration reduces firms' economic exposure to downside risk and changes the mode of internationalisation.

<sup>18</sup> Figure 4 reveals that the  $g_+$  surface is much more sensitive to changes in  $\sigma$  than the  $g_-$  surface.

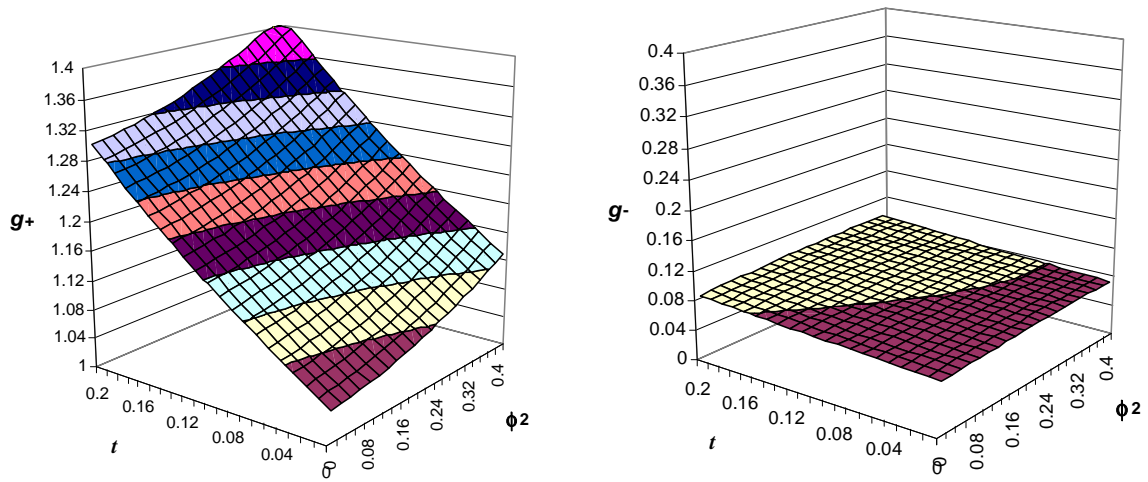
**Figure 5: The Threshold Values as Function of  $t$**

(The values of the other parameters are those presented in Appendix C)



**Figure 6: The Threshold Values as Functions of  $t$  and  $\phi_2$**

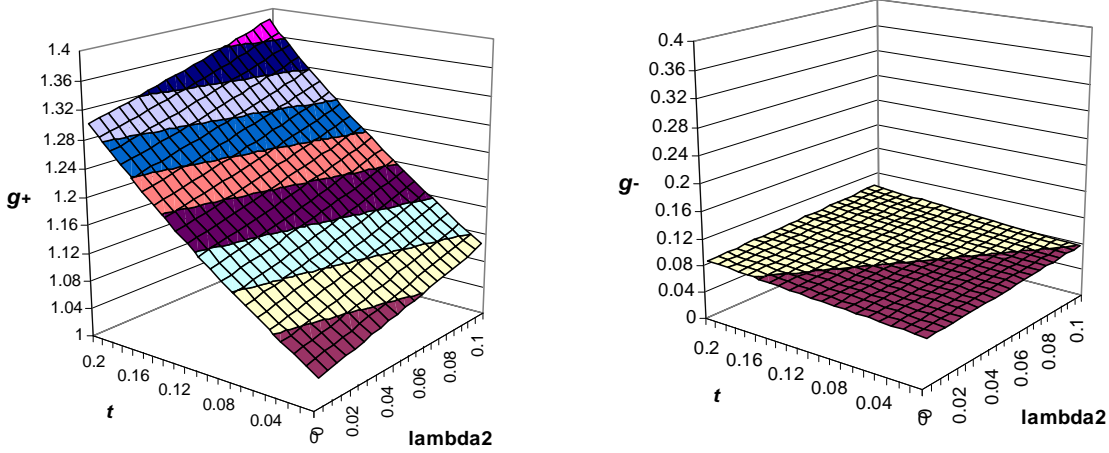
(The values of the other parameters are those presented in Appendix C)





**Figure 7: The Threshold Values as Functions of  $t$  and  $\lambda_2$**

(The values of the other parameters are those presented in Appendix C)



## 5. Summary Remarks and Conclusions

Using standard methods of stochastic calculus, we have looked in detail at the link between political uncertainty, economic integration and foreign direct investment spending by employing ideas and analytical techniques developed in the real options literature. Of course, the model developed in this paper is stylized and may not capture all of the details. However, our model clarifies thinking on the inter-linkages between policy uncertainty, option value and the timing of FDI at the firm level. The main result is that an uncertain political environment exerts a non-trivial influence upon FDI decisions. Furthermore, economic integration reduces the impact of policy uncertainty. These appealing insights can enrich theory by clarifying issues concerning the "if" and "when" of FDI.

An important feature of our model is that the opportunity to invest or disinvest is assigned to one firm only, i.e. the analysis was decidedly partial equilibrium. Yet it is obvious that one cannot just translate mechanically the above microeconomic results to aggregate investment. One implication is that waiting may no longer be feasible when FDI is available to any of several firms. There can be strategic situations with more firms, where moving first may be profitable. In practice, these considerations may call for early investment at the same time that political uncertainty suggests waiting. The optimal choice would then have to balance the two. To assess the role of political uncertainty in aggregate investment it is also essential to take explicitly into consideration the heterogeneity of individual firms' investment decisions. Bertola and Caballero (1994) have explored the implications of irreversibility for aggregate investment in a model in which individual firms' investment proceeds in discontinuous bursts. Individual investments are not synchronized, and firms are subject to idiosyncratic uncertainty in addition to aggregate uncertainty. As a result, aggregate uncertainty shows smoothness and a shock may take a long time to develop its full impact. Finally, the discussion

ignored the ability of, and incentives for, firms to diversify their capital stock internationally in times of political uncertainty. This diversification may partially offset the forces highlighted here.

## Appendix A: The Derivation of Equation (17)

Equation (16) is a differential equation of a familiar form. Our experience suggests that the solution takes the form

$$(A1) \quad q = BgK^{1-a}.$$

Then, we have  $q_g = BK^{1-a}$ ,  $q_{gg} = 0$ ,  $q_K = (a-1)BgK^{-a}$ ,  $q(g(1-\phi_2)) = Bg(1-\phi_2)K^{1-a}$ , and  $q(g(1+\phi_1)) = Bg(1+\phi_1)K^{1-a}$ . Substituting into equation (16) yields

$$(A2) \quad (r + \delta)B = a(1-t) - \delta(a-1)B + \eta B + \lambda_1 [B(1+\phi_1) - B] - \lambda_2 [B - B(1-\phi_2)].$$

Rearranging and collecting terms yields

$$B = \frac{a(1-t)}{r + \delta a - \eta - \lambda_1 \phi_1 + \lambda_2 \phi_2}.$$

It is then straightforward to obtain equation (17).

## Appendix B: The Derivation of Equations (18) and (19)

The homogeneous part of the Bellman's equation is denoted by:

$$(B1) \quad (r + \delta)q = -\delta q_K K + \eta g q_g + \frac{\sigma^2}{2} g^2 q_{gg} + \lambda_1 [q(g(1+\phi_1)) - q] - \lambda_2 [q - q(g(1-\phi_2))].$$

The homogeneous solutions should have the same components as in particular solutions. Assume the homogeneous solutions have the functional form

$$(B2) \quad q = A(gK^{1-a})^\beta.$$

Then we have

$$(B3) \quad -\delta q_K K = -\delta \beta (1-a) A (gK^{1-a})^\beta,$$

$$(B4) \quad \eta g q_g = \eta \beta A (gK^{1-a})^\beta,$$

$$(B5) \quad \frac{1}{2} \sigma^2 g g q_{gg} = \frac{1}{2} \sigma^2 \beta (\beta - 1) A (gK^{1-a})^\beta,$$

$$(B6) \quad q(g(1+\phi_1)) = (1+\phi_1)^\beta A (gK^{1-a})^\beta,$$

$$(B7) \quad q(g(1-\phi_2)) = (1-\phi_2)^\beta A (gK^{1-a})^\beta.$$

Now substitute into equation (B1). It is straightforward to obtain the following characteristic equation:

$$(B8) \quad \frac{1}{2} \sigma^2 \beta (\beta - 1) - \delta \beta (a - 1) + \eta \beta + \lambda_1 [(1+\phi_1)^\beta - 1] - \lambda_2 [1 - (1-\phi_2)^\beta] - (r + \delta) = 0$$

Equation (19) is thus proven.

### Appendix C: The Benchmark Parameters

We set the central benchmark parameters as follows:  $\sigma = 0.18$ ,  $\eta = 0.03$ ,  $r = 0.03$ ,  $\delta = 0.08$ ,  $\lambda_1 = 0.05$ ,  $\lambda_2 = 0.05$ ,  $\phi_1 = 0.2$ ,  $\phi_2 = 0.2$ ,  $p_K^+ = 1.0$ ,  $p_K^- = 0.2$ ,  $a = 0.65$ , and the initial value for capital ( $K$ ) = 100. All these parameters seem reasonable on an annual basis.

The most straightforward measure of transport costs in international trade is the difference between the cif and fob quotations of trade. The difference between these two values is a measure of the cost of getting an item from the exporting country to the importing country. Hummels (2007) has shown that freight rates have declined in the post World War II period. Given the evidence in Radelet and Sachs (1998), we assume  $t = 0.05$  as our benchmark parameter.

To motivate the analysis of policy uncertainty, special attention has to be paid to the calibration of the Poisson processes. The Poisson process implies that the likelihood of a policy change is determined by the arrival rate  $\lambda$ . This means that the time  $t$  one has to wait for the switch event to occur is a random variable whose distribution is exponential with parameter  $\lambda$ :

$$(C1) \quad F(t) \equiv \text{prob}\{\text{event occurs before } t\} = 1 - e^{-\lambda t}$$

The corresponding probability density is

$$(C2) \quad f(t) \equiv F'(t) = \lambda e^{-\lambda t}$$

In other words, the probability that the event will occur sometime within the short interval between  $t_0$  and  $t_0 + dt$  is approximately  $\lambda e^{-\lambda t} dt$ . In particular, the probability that it will occur within  $dt$  from now (when  $t = 0$ ) is approximately  $\lambda dt$ . In this sense  $\lambda$  is the probability per unit of time. Moreover, the number of policy changes ( $x$ ) that will take place over any interval of length  $\Delta$  is distributed according to the Poisson distribution

$$(C3) \quad g(x) \equiv \text{prob}\{x \text{ event occur}\} = \frac{(\lambda \Delta)^x e^{-\lambda \Delta}}{x!}$$

whose expected value is the arrival rate times the length of the interval  $\lambda \Delta$ . We can back out from equation (C3) the agent's beliefs about policy changes. As a guide to calibration, the Table below provides the probabilities that either one ( $x = 1$ ) or three ( $x = 3$ ) jumps will occur within 5 years ( $\Delta = 5$ ) or 10 years ( $\Delta = 10$ ) for the three arrival rates  $\lambda = 0.01$ ,  $\lambda = 0.05$  and  $\lambda = 0.10$ , respectively. For example, for  $\lambda = 0.05$  the probability that one jump will occur within 5 years is 19.5 percent.

**Table: Jump Probabilities for the Poisson Process**

	$\lambda = 0.01$	$\lambda = 0.05$	$\lambda = 0.10$
prob{1 event in 5 years}	0.048	0.195	0.303
prob{3 events in 5 years}	0.000002	0.002	0.013
prob{1 event in 10 years}	0.090	0.303	0.368
prob{3 events in 10 years}	0.0001	0.012	0.061

The results indicate that for  $\lambda = 0.10$  the firm faces a very substantial exposure to political risk. The variability embodied with  $\lambda_{1,2} = 0.05$  therefore seems to be a plausible and realistic parameterization of the model for emerging market and transition economies.

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